The Effects of Economic Integration on the Provision of Mandatory Education as a Redistributive Policy

Elena del Rey Canteli*

October 1998

Abstract

The aim of this paper is to investigate the implications of increased student mobility on the level of education publicly provided after opening the borders between two similar countries. As a preliminary result, it will be shown that some public provision of mandatory education can be welfare improving when an optimal linear income tax exists. Compared to the autarchic optimal provision level, mandatory education will be underprovided in both countries at the symmetrical Nash equilibrium.

Keywords: public provision of private goods, education, efficiency, optimal taxation, fiscal competition.
JEL Classification: H42, H21, H52, H87.

---

*CORE, Université catholique de Louvain. E-mail: delrey@core.ucl.ac.be.
The author gratefully acknowleddges financial support from Fundación Ramón Areces, Spain. I thank Maurice Marchand and Pierre Pestieau very much for their essential comments. Remaining errors are mine.
This text presents research results of the Belgian Program of Interuniversity Poles of Attraction initiated by the Belgian State, Prime Minister's Office, Science Policy Programming. The scientific responsibility is assumed by the author.

1. Introduction

The existence of efficiency losses associated with taxing, rooted in the discouragement effects of taking earned income away from individuals, limits the scope for income redistribution. In this sense, taxes and transfers may prove insufficient as redistributive tools. Taking this into account, it may be sensible for policy-makers to operate on the expenditure side of the budget as an attempt to compensate for a redistribution deficit. The objective would be to modify individual economic decisions, distorted by taxation, by means of the other type of fiscal policy instrument: expenditures. If this were possible, some of the efficiency loss could be recovered, and more income redistribution could be accomplished with less harm to overall economic efficiency.

This paper follows Guesnerie and Roberts(1984), who were concerned with the desirability of quantity controls such as rationing or in-kind transfers in the presence of distortive taxes. In particular, they show that small quota policies may be welfare enhancing when a distortive linear commodity tax system exists. Our paper is also related to Munro(1991) and Gahvari(1995). Conclusions similar to those of Guesnerie and Roberts(1984) have been reached as well in a nonlinear income taxation framework by Boadway and Marchand(1995) and Boadway, Marchand and Sato(1997) for example.

The intuition underlying the present work is the following: the taxation of income has a negative effect on the incentives to carry out some activities that, while contributing to the generation of income, also involve a disutility for the individual. Labor is generally referred to when dealing with disincentives caused by wage income taxation. In addition, we will focus here on the distortionary effect of taxes on the demand for education. Although not directly taxed, education affects productivity and wages, which is the reason why the demand for this private good may be reduced when taxing wage income. In line with the above literature, if the consumption of an extra amount of education is imposed on the individuals, the inefficiency resulting from the tax can be diminished, thus allowing for a higher level of redistribution.

Once established the desirability of public provision of mandatory education, we question what happens to the efficiency enhancing effect of these in-kind transfers when we allow the students to freely move across the barriers of two countries. The traditional distortions caused by taxation in a closed economy limit themselves to a disincentive to develop the taxed activity. However, in an open economy we need to take into account the additional effect of repulsion of taxpayers and attraction of beneficiaries of public expenditures in the area where the tax is levied. This endows the economies with much larger tax base's elasticities and in this sense it can be stated that the increased mobility of individuals implied by economic integration makes redistribution more difficult. Aware of this fact, the different governments of the European Union countries may try to affect the size of their tax bases, attracting tax payers and/or repelling beneficiaries by means of their fiscal policies, thus enrolling in a process of fiscal competition.

In our model, individuals are mobile as students, not as workers. This implies that they always pay taxes in their countries of origin, where they work, but may be attracted by the spending level in education undertaken by another country. As the governments are aware of this, we shall be interested in the characterization of the symmetric equilibrium in terms of education provision resulting from free student mobility across the border between two identical countries.

The paper is organized as follows: Section 2 establishes the desirability of public provision of mandatory education in an autarchic model. Then, in Section 3, the model is extended to the open border case. We will then be ready to analyze the effects of free mobility of students on the level of education provision chosen by the governments. Section 4 will conclude.

2. THE AUTARCHIC MODEL

2.1. Characterization of Individual Behavior and Welfare

Consider a simple model in which all individuals have the same utility function and differ only in ability, which, together with the education they decide to acquire, affects the wage they earn, w. An individual maximizes utility by the choice of labor supply, L, and a consumption bundle. The latter consists of a composite good, x, and education, e. Total education e is the sum of (per capita) publicly provided mandatory education, g, and private education, z, that may supplement that provided by the public sector. The consumption good x is taken as the numeraire and the price of z is assumed to be 1 and constant, for simplicity.

Thus, individuals of ability type i $(i = 1, ..., n)$ supplying L_i units of labor and demanding z_i units of education earn the gross income $y_i = w_i(g + z_i)L_i$. A percentage t of this wage income is paid in taxes to the government. From that government they receive a uniform lump sum transfer, G, and a certain amount of publicly provided education, g. The individual optimization problem is:

$$\underset{L_i, z_i \geq 0}{Max}\ u(x_i, L_i).$$

$$\text{subject to } (1-t)w_i(g+z_i)L_i + G = x_i + z_i \tag{2.1}$$

Substituting x_i in the utility function from the budget constraint and differentiating yields the first order conditions for individual utility maximization. For simplicity, we assume the existence of an interior solution for labor. Thus, individual labor supply will be that which satisfies:

$$u_x^i(1-t)w_i(g+z_i(g,G,t)) = -u_L^i. \tag{2.2}$$

It is important to impose, however, that z be non-negative $(z_i \geq 0)$. Otherwise those individuals who desire to consume low levels of education would be able to retrade part of the in-kind public provision of mandatory education. The policy would then prove useless, it being equivalent to a lump-sum transfer. Therefore, we will make use of the Kuhn-Tucker conditions, according to which:

$$\begin{aligned} w_e^i L_i &= \frac{1}{1-t} \quad \text{if } z_i > 0, \\ w_e^i L_i &< \frac{1}{1-t} \quad \text{otherwise.} \end{aligned} \tag{2.3}$$

where the variable with respect to which we differentiate appears as a subscript.

From the first order conditions we obtain the demand for z, $z_i(g,G,t)$, and the supply of L, $L_i(g,G,t)$, as functions of the parameters set by the government. Substituting these back into the utility function yields the indirect utility function, which provides us with the maximum utility attained by individuals of ability type i given the exogenous government policy parameters t, G and g:

$$v_i(g,G,t) \equiv u\left[(1-t)w_i(g+z_i(.))L_i(.) + G - z_i(.), L_i(.)\right]. \tag{2.4}$$

We are now ready to analyze the effect of marginal changes of each policy parameter on individual welfare. By the envelope theorem, the derivatives of the indirect utility function with respect to the exogenous variables are

$$v_t^i = -u_x^i w_i L_i, \tag{2.5}$$

$$v_G^i = u_x^i, \tag{2.6}$$

$$\begin{aligned} v_g^i &= u_x^i(1-t)w_e^i L_i \quad \text{if } z_i \geq 0 \text{ is binding,} \\ &= u_x^i \quad \text{otherwise.} \end{aligned} \tag{2.7}$$

When individual decisions are not constrained by that of mandatory public provision g, we have from (2.3) that $(1-t)w_e^i L_i = 1$. In this case, we conclude from (2.6) and (2.7) that the effect of a marginal increase in public expenditure via a lump-sum transfer is exactly the same as that of a marginal increase in public education expenditure. Precisely, when an individual who has decided to supplement mandatory education by private education is provided with a further free amount of that service, an amount of income is liberated due to the substitutability between private and public education that is effectively equivalent to a rise in G, the lump-sum transfer, and has the same income effect $(v_G^i = v_g^i)$.

If, on the other hand, the non-negativity constraint on z is binding, (2.3) implies that $(1-t)w_e^i L_i < 1$, and so $v_g^i < v_G^i$ from (2.6) and (2.7). If the individual had decided not to supplement mandatory education by private education, a rise of public provision will compel him to consume still more than what he would have freely chosen to acquire (i.e., that does not maximize his utility or does not represent an optimal choice) and the extra utility derived from the government's provision of education would be lower than that of the provision of lump-sum income. Consequently, the individual utility derived from the mandatory education policy would in this case be lower than that of an equal amount of lump-sum income.

Therefore, at the individual level, the in-kind transfer does not seem especially recommendable, as it is either equivalent to or worse than a lump-sum transfer in terms of individual welfare. So, it is our task to test the possibility that in the presence of some inefficiency, like a distortionary tax, such a compelled consumption of education may be optimal, and to specify the conditions under which this will be the case.

2.2. The Government

Let the government's objective consist of maximizing a utilitarian social welfare function of the form $\sum_i N_i v_i(g, G, t)$, where N_i is the percentage of individuals of ability type i and all individuals are identically weighted. Assume also that it does so constrained by its tax revenue, $\sum_i N_i(tw_i - g - G) = 0$. The Lagrangian characterizing social welfare is thus:

$$W = \sum_i N_i v_i(.) + \mu \sum_i N_i \left[tw_i(g + z_i(.))L_i(.) - g - G \right]. \tag{2.8}$$

Our purpose is to characterize the taxes that are optimally set by the welfare-maximizing government. Consider first the case in which g is zero, i.e.: in this first stage the only instruments available to the government to redistribute income are a combination of proportional income taxation and lump-sum transfers (linear income taxes).

The first-order conditions for social welfare maximization with respect to G and t are:

$$\sum_i N_i v_G^i + \mu \sum_\iota N_i \left[t\frac{\partial y_i}{\partial G} - 1 \right] = 0 \tag{2.9}$$

$$\sum_i N_i v_t^i + \mu \sum_\iota N_i \left[t\frac{\partial y_i}{\partial t} + y_i \right] = 0 \tag{2.10}$$

where $y_i = w_i L_i$ as introduced earlier.

We assume the tax rate, and consequently G, to be positive.

2.3. Public Provision of Mandatory Education

Starting from the optimal initial situation just described, we want to know, in the first place, whether the introduction of mandatory education dg would be welfare improving. When increasing g from zero, as long as the non-negativity constraint $z_i \geq 0$ remains non-binding for every individual, mandatory education acts as a lump-sum transfer. Define g_i $(i = 1, ..., n)$ as the value of g at which $z_i \geq 0$ becomes binding, and $g_{\min}$ as the smallest of all g_i's. Let k be the ability type[1] for which $g_{\min}$ applies, i.e.: $g_k = g_{\min}$.

Proposition 2.1. *At $g = g_{\min}$, a small increase in g, $dg > 0$ is welfare improving.*

The effect of this measure on welfare is given by:

$$\frac{\partial W}{\partial g} = \sum_i N_i v_g^i + \mu \sum_\iota N_i \left[t\frac{\partial y_i}{\partial g} - 1 \right] \tag{2.11}$$

[1] If we assume that low ability individuals demand less education, k will be the lowest ability type, the one that is crowded out first. However, it could also be the case that the highest ability types, being more productive, would require lower education demand levels, and, thus, be the ones whose private demand is crowded out first. k would then be the highest ability type. An assumption of this type is an unnecesary restriction in the present work. Hence, we do not make an assumption about the relationship between the demanded education levels and ability.

Substracting from the right hand side of (2.11) the expression in (2.9) we obtain at $g = g_{\min}$:

$$\frac{dW}{dg} = N_k u_x^k \left[(1-t)w_e^k L_k - 1\right] + \mu N_k t \left[\frac{\partial y_k}{\partial g} - \frac{\partial y_k}{\partial G}\right] \qquad (2.12)$$

since at $g = g_{\min}$, for $i \neq k$

$$v_g^i = v_G^i \text{ and } \frac{\partial y_i}{\partial g} = \frac{\partial y_i}{\partial G}{}^2.$$

Notice that, since the derivative is taken at $g = g_k$ we have from (2.3), that $(1-t)w_z^k L_k = 1$ and the first term in (2.12) disappears. In fact, as Guesnerie and Roberts (1984) also point out, whether individuals are initially constrained or not when the quota is introduced is a basic determinant of the results. When the individual is unconstrained, his optimal choice may be represented by his indifference curve being tangential to his budget line. If he is forced to move along his budget line from this optimal point, then, initially (i.e.: for marginal changes), this is equivalent to moving along the indifference curve. Thus, "to the first order there will be no loss in utility to the consumer". Therefore:

$$\frac{dW}{dg} = \mu N_k t \left[\frac{\partial y_k}{\partial g} - \frac{\partial y_k}{\partial G}\right] > 0 \text{ if } \frac{\partial y_k}{\partial g} - \frac{\partial y_k}{\partial G} > 0$$

where

$$\frac{\partial y_k}{\partial g} = w_e^k L_k + w_k \frac{\partial L_k}{\partial g}$$

and

$$\frac{\partial y_k}{\partial G} = w_k \frac{\partial L_k}{\partial G},$$

since z_k remains constant, as the non-negativity constraint on z_k is binding. Thus:

$$\frac{\partial y_k}{\partial g} - \frac{\partial y_k}{\partial G} = w_e^k L_k + (\frac{\partial L_k}{\partial g} - \frac{\partial L_k}{\partial G})w_k$$

[2] The comparative statics of labour supply and education demand, that lead to this and other results, are detailed in the Appendix.

The comparative statics of labor supply (Appendix) show that, at $g = g_{\min}$,

$$\frac{\partial L_k}{\partial g} - \frac{\partial L_k}{\partial G} > 0$$

from which we conclude that a small increase in g, $dg > 0$, is welfare improving.

Equation (2.12) may be interpreted as the welfare gain derived from an increase in public provision of education g being financed by an equivalent decrease in the lump-sum transfer G. A small increase of g from $g = g_{\min}$ is then strictly welfare improving. But, what happens as g is increased further?

Proposition 2.2. *Given an optimal linear income tax, there exists a level of $g > g_{\min}$ at which (local) optimality is achieved.*

For a given g, let now j be the last type for which demand for private education is zero, given that individual types are ranked in increasing value of their private education demand. Formally: $z_i = 0 \quad (i \leq j)$ and $z_i > 0 \quad (i > j)$. The welfare of all individual types with private demands for education greater than that of j will not be affected by a rise in g, as we can infer from the proof of Proposition 2.1 (see Appendix). Hence, substracting as before from the right-hand side of (2.11) the expression in (2.9) we obtain, at $g > g_{\min}$:

$$\frac{dW}{dg} = \sum_{i=1}^{j} N_i u_x^i \left[(1-t)w_z^i L_i - 1\right] + \mu \sum_{i=1}^{j} N_i t \left[\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G}\right] \tag{2.13}$$

where

$$\begin{aligned} \frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G} &= w_e^i L_i + \frac{\partial z_i}{\partial g} + \left(\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G}\right) w_i \quad & i \leq j, \\ &= 0 & i > j. \end{aligned} \tag{2.14}$$

As

$$\frac{dL_i}{dg} - \frac{dL_i}{dG} > 0, \; i \leq j$$

we conclude that the last term on the right-hand side of 2.13 is positive. As to the first term, since the restriction $z_i \geq 0$ is binding for all $i \leq j$, it is negative from (2.3). Note that as g increases the constraint $z_i \geq 0$ becomes binding for more individuals. On the other hand, if individual private demand for education is not initially constrained by the public policy, there is no direct effect on individual utility of a marginal increase in g financed by a reduction of G. Therefore, if the policy change is welfare improving, is not through its direct effect on individual utilities, but as it manages to raise income and tax revenue, thus allowing for a larger level of redistribution without causing further distortions.

Overall, it has been shown that, for some value of g larger than $g_{\min}$, $\frac{dW}{dg}$ will be strictly positive and that, as g increases further, more and more elements in this expression become negative. Eventually, the sign of (2.13) will change from positive to negative, reflecting the existence of a local maximun in g. It may not be a global maximum, as second-best problems like this are in general not guaranteed to satisfy standard convexity properties. However, what is at stake here is not the global optimality, but the convenience of imposing a positive quota on individual education consumption. The important point is that the ability for compulsory education to increase welfare is not limited to marginal amounts dg, even though the optimum thus attained may only be a local one.

In the end, the reason why mandatory education is welfare improving amounts simply to its allowing for higher levels of income and, thus, tax revenue. When individuals are initially constrained, the negative effect on individual utility is to be balanced with the positive effect on tax revenue, so that an optimal level of g may still be found at the point where these two compensate each other.

In intuitive terms, the effect of mandatory public provision of education on welfare can be explained as follows. Recall that education was privately demanded because of its positive effect on the wage earned via a higher productivity. A positive marginal tax rate on labor income, t, takes some of that extra wage earned away to finance government spending. Since education, as labor, imposes a disutility on the individual, the tax system distorts private decisions by making the acquisition of education less attractive: individuals are discouraged to work and study whenever part of their wage income is taken away by the government in the form of taxes. Mandatory education can marginaly move education levels close to those that would prevail without labor income taxes, thus lessening the efficiency loss associated to taxes and allowing for larger levels of income redistribution.

In fact, without such a concern for redistribution $t = G = 0$ and there would be no reason to introduce a measure as g, that distorts individual decisions, so $g = 0$. It is due to the existence of redistributive taxes that efficiency losses originate, and any policy that manages to reduce these inefficiencies must be welfare improving.

3. Open Border Model

Having confirmed the appropriateness of the provision of a uniform in-kind education transfer, we are now ready to open the borders and let the two countries' public provision of education policies interact. The two countries, assumed to be identical in all respects, will compete to achieve, by means of their public education policy parameters, the greatest possible outcome in terms of welfare, given the in-kind education transfer implemented by the other.

3.1. Student Mobility

When the frontiers are opened, the citizens are not restricted to the benefits provided in their own jurisdiction any more, but may benefit from the most profitable of local public policies provided elsewhere, as they are free to move. It is assumed here that the governments are not allowed to discriminate the foreign citizens in any way.

In these circumstances, the absence of mobility costs generally brings about what is known as *bang bang* solutions, with one single country having to educate all of the individuals, the other staying without students. It is an unnecessary source of instability, since, in general, agents face different degrees of mobility-related disutility.

Individual mobility costs will be represented by a function of the type suggested in Mansoorian and Myers (1993). There are M different degrees of attachment to the home country in each ability type, with M varying between 0 and 1. Attachment can be defined as a non-pecuniary benefit the individual derives from staying at home. The greater the attachment, the greater the mobility cost. Each individual is thus characterized, within her type, by her cost of moving to acquire education abroad, M_i. Let then the mobility cost function K_i of the type-i individual with attachment M_i be given by $K_i(M_i)$, with $K_i(0) = 0$. Thus, $K_i'(M_i) > 0 \;\text{ if }\; M_i \geq 0$. From the point of view of the home country $M_i < 0$ is the attachment of a foreign type-i individual. Foreign type-i individuals with $M_i < 0$ closer to zero (smaller in absolute value) have lower mobility costs (less attachment). Hence, $K_i'(M_i) < 0 \;\text{ if }\; M_i < 0$, and, since the two countries are identical in all respects, $K_i(M_i) = -K_i(-M_i)$. In what follows, K_i is expressed in numeraire and acts like a reduction in available income for an individual seeking education abroad.

Whenever the amount of publicly provided higher education is higher in the other country ($\widehat{g} > g$), some type-i individuals($M_i > 0$) will cross the border to benefit from the public education policy provided abroad. Let $\widetilde{M}_i$ be the attachment of the type-i individual who is indifferent between getting education at home or abroad. All individuals with M lower than $\widetilde{M}_i$ migrate. Thus, $\widetilde{M}_i > 0$ represents as well the number of type-i individuals who decide to get educated abroad. Conversely, $\widetilde{M}_i < 0$ represents the number of incoming students when $\widehat{g} < g$.

In a framework of economic integration the national governments cannot directly fix the number of migrants. However this number affects the levels of social welfare in each of the countries. Therefore, a migration equilibrium condition that determines the number of individuals in each of the jurisdictions needs to be included in the government's optimization programs.

In principle, we need to distinguish among four cases, according to whether or not individuals are constrained in their choice of education consumption by the public education provided at home and/or abroad. In effect, the individual constraint $z_i \geq 0$ may be binding both at home and abroad, at home and not abroad, abroad but not at home or neither at home nor abroad. However, since the countries are assumed identical in all respects, we shall be concerned with the identification of the optimal policy at the symmetrical Nash equilibrium and only the first and last cases will generally matter. On this basis, the partition of individuals between those whose private demand is crowded out by public provision ($i = 1, ..., j < n$) and those whose private demand is not crowded out by public provision ($i = j + 1, ..., n$) will be at equilibrium identical in the two countries.

3.1.1. Migration Equilibrium with $z_i \geq 0$ non-binding (Condition 1):

If the demand for private education is positive, as it is for individuals $i = j + 1, ..., n$, we have already seen how a marginal increase in g in the autarchic model has only an income effect on individual welfare. The same holds for the acquisition of a higher g by migration in the open economy case if this amount publicly provided abroad is still smaller than the private demand for education. In this case, the levels of publicly provided education at home and abroad will be responsible alone for the migration decisions. In fact, this case corresponds to the standard border-crossing problem. The migration equilibrium is characterized by the marginal *migrant* $\widetilde{M}_i$ being indifferent between acquiring its education in either country. In this case such a condition amounts to:

$$\widehat{g} - g = K_i(\widetilde{M}_i), \quad i = j+1, ..., n \tag{3.1}$$

How is the number of migrants affected by changes of g and $\widehat{g}$? Total differentiation of the migration equilibrium condition with respect to g and $\widehat{g}$ yields

$$\widetilde{M}_g^i = \frac{dM_i}{dg} = -\frac{1}{K_i'} < 0, \quad i = j+1, ..., n$$

and

$$\widetilde{M}_{\widehat{g}}^i = \frac{dM_i}{d\hat{g}} = \frac{1}{K_i'} > 0, \quad i = j+1, ..., n$$

Intuitively this just means that an increase in g involves an inflow of students and that the increase in $\hat{g}$ entails students' outflows. Notice that in this first case, in which the public provision does not exceed private demand of education, the other policy parameters, the tax rate and the lump-sum transfer, do not affect migration decisions.

3.1.2. Migration Equilibrium with $z_i \geq 0$ binding (Condition 2):

When the constraint $z_i \geq 0$ is binding, the increase in g causes the individual's wage rate to rise, which generally triggers off a change in labor supply. Therefore, a higher level of g no longer results exclusively in an income effect, but may affect individual utility through other ways. For this reason, overall utility under g and $\widehat{g}$ must be taken into account.

For the marginal migrant the utility level attainable at home and abroad shall be the same. For students residing in the home country, the migration equilibrium condition becomes:

$$v_i(g, G, t) \equiv v_i(\widehat{g}, G - K_i(\tilde{M}_i), t) \tag{3.2}$$

for every type of individuals $i = 1, ..., j < n$ for which the constraint $z_i \geq 0$ is binding. Let us note that the tax parameters (t, G) are identical on the left and on the right-hand sides of these conditions. This is because individuals getting education abroad are subject to the tax system of their residence country.

Therefore, migration decisions depend simultaneously on $\widehat{g}$, g, t and G. The comparative statics of $\tilde{M}_i$ yield:

$$\tilde{M}^i_{\hat{g}} = \frac{\partial \tilde{M}_i}{\partial \hat{g}} = \frac{-\hat{u}^i_x\,(1-t)\,w^i_{\hat{g}}\hat{L}_i}{-K'_i\hat{u}^i_x} > 0 \tag{3.3}$$

$$\tilde{M}^i_{g} = \frac{\partial \tilde{M}_i}{\partial g} = \frac{u^i_x\,(1-t)\,w^i_{g}L_i}{-K'_i u^i_x} < 0 \tag{3.4}$$

$$\tilde{M}^i_{G} = \frac{\partial \tilde{M}_i}{\partial G} = \frac{u^i_x - \hat{u}^i_x}{-K'_i u^i_x} \tag{3.5}$$

$$\tilde{M}^i_{t} = \frac{\partial \tilde{M}_i}{\partial t} = \frac{-u^i_x w_i(g)L_i + \hat{u}^i_x w_i(\hat{g})L_i}{-K'_i u^i_x} \tag{3.6}$$

where u and $\hat{u}$ stand respectively for the levels of utility attained by individual i when getting education at home and abroad.

When unconstrained in his choice of education, the marginal migrant does not benefit from an income effect by getting education abroad, and he consumes the same optimal education levels at home or abroad, so that his tax liability is unaffected by the decision to move or not. Hence, $\tilde{M}^i_G$, $\tilde{M}^i_t$ equals zero for $i = j+1, ..., n$. Constrained individuals' final education levels, on the contrary, are determined by the mandatory levels. If these differ across countries, the magnitude of the effect of education on wages is different for marginal migrants when deciding to study at home or abroad . Therefore the gross incomes and the tax liabilities of these constrained individuals may differ if they decide to study abroad. Under these circumstances marginal changes in the fiscal parameters t and G may affect their decision to move. Consequently, $\tilde{M}^i_G \neq 0$, $\tilde{M}^i_t \neq 0$ for $i = 1, ..., j < n$.

3.2. The Governments. Effect of Migration on Welfare.

The two identical countries considered care exclusively for the well-being of their national citizens. In fact, their objective functions will differ slightly depending upon whether the country suffers an inflow or outflow of students, and, in both cases, as compared to the autarchic case. For this reason, it seems appropriate to consider that two different regimes can take place according to whether $\widehat{g} \geq g$ or $g \geq \widehat{g}$. At the frontier, i.e., at $\widehat{g} = g$ a non-differentiability problem may exist. What follows will be used to show that at $\widehat{g} = g$, the derivatives of the social welfare function corresponding to both regimes (i.e. the left and right derivatives) are the same and, hence, non-differentiability is ruled out.

In order to do that we need to take into account that the effect of in-kind provision of education on welfare depends critically on whether or not individuals are constrained in their choice of private education. This circumstance will be considered when analyzing the effect of migration on welfare.

Recall that individual types have been ranked by increasing z_i and hence of g_i (the value of g at which z_i becomes binding). Also, we have ruled out the possibility of having individual types whose constraint $z_i \geq 0$ is binding at home and not abroad or vice versa, given that this situations will never take place at the symmetrical equilibrium. Ability types $i = 1, ...j < n$ are thus those for which $z_i \geq 0$ is binding at home as well as abroad. Conversely, ability types $i = j+1, ...n$ are thus those for which $z_i \geq 0$ is not binding, neither at home nor abroad.

REGIME 1: $\widehat{g} \geq g$.

If the expenditure on public provision of education is higher abroad, $\tilde{M}_i$ individuals of each corresponding ability type will leave their home country to benefit from the higher level of public education supplied in the other country (i.e., $\tilde{M}_i > 0$). The objective function of the home country's government is in this case:

$$\begin{aligned} W &= \sum_{i=1}^{n} \left((N_i - \tilde{M}_i\,(.))v_i(.) + \int_0^{\tilde{M}_i(.)} \widehat{v}_i\,(.)\,dM_i \right) \\ &\quad + \mu \sum_{i=1}^{n} \left((N_i - \tilde{M}_i\,(.))ty_i(.) + t \int_0^{\tilde{M}_i(.)} \widehat{y}_i(.)dM_i \; - N_iG - (N_i - \tilde{M}_i\,(.))g \right) \end{aligned} \tag{3.7}$$

where $\widehat{v}_i(.)$ and $\widehat{y}_i(.)$ stand for the value of the indirect utility function and income level respectively when education $\widehat{g}$ is obtained abroad.

Therefore:

$\widehat{v}_i(.) = \widehat{v}_i(\widehat{g}, G - K_i(M_i\,(.)), t)$, if $i = 1, ..., j$.

$\widehat{v}_i(.) = \widehat{v}_i(\widehat{g}, G + \widehat{g} - g - K_i(M_i\,(.)), t)$, if $i = j+1, ..., n$.

$\tilde{M}_i$ individuals move to the other country to consume the freely provided $\widehat{g}$. They enjoy utility $\widehat{v}_i(.)$ instead of $v_i(.)$ and receive income $\widehat{y}_i(.)$ instead of $y_i(.)$. Even though they move, they do so only in order to consume the public education provided abroad, so they still figure in the objective of the government at the home country and they still pay their (higher) taxes and receive the corresponding lump-sum transfer there.

Recall that, of the initially unconstrained individuals $i = j+1, ..., n$, those who move to the country that provides a higher g will benefit from an income effect equal to the transfer differential $\widehat{g} - g$ minus the mobility cost incurred. The constrained individuals $i = 1, ..., j$ that choose to get education abroad receive the further education $(\widehat{g} - g)$ for free. This is the reason why they consume more education than they would have initially chosen to and bear the mobility cost $K_i(M_i)$.

In this situation, a marginal positive variation in the domestic country's public provision of education, g, has the following effect on its own welfare:

$$\begin{aligned}\frac{\partial W}{\partial g} &= \sum_{i=1}^{j}(N_i - \tilde{M}_i\,(.))u_x^i(1-t)w_e^i L_i + \sum_{i=j+1}^{n}(N_i - \tilde{M}_i\,(.))u_x^i \\ &\quad + \mu \sum_{i=1}^{n}\left((N_i - \tilde{M}_i\,(.))t\frac{\partial y_i(.)}{\partial g} - t\tilde{M}_g^i(y_i(.) - \widehat{y}_i(.)) - (N_i - \tilde{M}_i\,(.)) + g\tilde{M}_g^i\right)\end{aligned} \tag{3.8}$$

where migration equilibrium conditions 1 and 2 ((3.1) and (3.2)) have been used on the utility side.

REGIME 2: $\widehat{g} \leq g$.

$\tilde{M}_i$ foreign students ($\tilde{M}_i < 0$) come to our home country, as the expenditure level on education is lower in theirs and the home government cannot put in place any discriminatory policy, such as fees, on them. However, they do not figure explicitly in our domestic social welfare function. Once trained, these individuals go back to their countries, where they pay taxes and receive the corresponding uniform lump-sum income G. The objective function of the country identified as "home" is now:

$$W = \sum_{i=1}^{n} N_i v_i(g, G, t) + \mu \sum_{i=1}^{n}\left[N_i t y_i(g, G, t) - (N_i - \tilde{M}_i)g - N_i G\right] \tag{3.9}$$

where $(N_i - \tilde{M}_i) > N_i$. Therefore, the effect of a marginal increase in g will now be:

$$\frac{dW}{dg} = \sum_{i=1}^{n} N_i v_g^i + \mu\left[N_i t\frac{\partial y_i}{\partial g} - (N_i - \tilde{M}_i) + g\tilde{M}_g^i\right] \tag{3.10}$$

Notice that at $\widehat{g} = g$, (3.8) and (3.10) boil down to a same expression since $\tilde{M}_i = 0$ for all i. Thus, non-differentiability of the welfare function with respect to g at $\widehat{g} = g$ is ruled out.

3.3. The Symmetrical Nash Equilibrium

The purpose of this Subsection is to characterize the symmetrical Nash equilibrium $\{(t, G, g), (\widehat{t}, \widehat{G}, \widehat{g})\}$. At this equilibrium neither the home country nor the foreign country have an incentive to modify its policy choice for a given policy choice of the other country. Focusing on the home country this means that t and G satisfy the following first-order conditions at the Nash equilibrium:

$$\frac{\partial W}{\partial t} = -\sum_{i=1}^{n} N_i u_x^i y_i + \mu[\sum_{i=1}^{n}(N_i t \frac{\partial y_i}{\partial t} - N_i y_i + M_t^i)] = 0 \quad (3.11)$$

$$\frac{\partial W}{\partial G} = \sum_{i=1}^{n} N_i u_x^i + \mu[\sum_{i=1}^{n}(N_i t \frac{\partial y_i}{\partial G} - N_i + M_G^i)] = 0 \quad (3.12)$$

Since $g = \widehat{g}$ at the symmetrical equilibrium the consumption and labor supply levels attained by i when studying at home or abroad will coincide. Hence, $u_x^i = \hat{u}_x^i$, and, from (3.5) and (3.6), $M_t^i = M_G^i = 0$. Marginal changes in t or G will not affect the students' decision to move. In this case, these two conditions for the optimal choice of t and G coincide with those in the autarchic model.

Proposition 3.1. *At the symmetric Nash equilibrium, public provision of mandatory education is less welfare improving than in the autarchic case.*

Focusing once more on the home country, its mandatory education level must satisfy at the symmetrical Nash equilibrium (where $g = \widehat{g}$) :

$$\begin{aligned} \frac{\partial W}{\partial g} &= \sum_{i=1}^{n} N_i u_x^i (1-t) w_g^i L_i + \sum_{i=k+1}^{n} N_i u_x^i \\ &\quad + \mu \left[\sum_{i=1}^{n}(N_i t \frac{\partial y_i}{\partial g} - N_i + g M_g^i)\right] \end{aligned} \quad (3.13)$$

As G is optimally chosen, we can follow the same steps as those applied in Section 2.3 to obtain 2.13. Thus, substracting from the right-hand side of (3.13) the expression in (3.12) we obtain:

$$\frac{\partial W}{\partial g} = \sum_{i=1}^{j} N_i u_x^i \left[(1-t) w_g^i L_i - 1\right] + \mu \sum_{i=1}^{j} N_i t \left[\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G}\right] + \mu g M_g^i = 0$$

where the equivalence between the public provision of the in-kind and lump-sum transfer for individuals $i = j+1, ..., n$ has been used. The only difference between this expression and (2.13), that determined the optimal level of public provision of mandatory education in the autarchic case, is the last term on the right hand side, $\mu g M_g^i < 0$.

The benefits from the public provision of education are thus lower when we open the borders, due to the import of foreign students, which is represented by the term $M_g^i < 0$.

Therefore at the symmetrical Nash equilibrium the common value of g_N and $\widehat{g}_N$ is lower than the level of public provision of education chosen in the autarchic case. Underprovision of mandatory public education results in both countries when opening the borders and letting students freely move across them.

4. Conclusion

The imposition of a small uniform quota on the consumption of education has been shown to be desirable when the existence of a linear wage income tax drives the economy away from a first best Pareto efficient solution. This result follows directly from Guesnerie and Roberts (1984) where it is stated that to help minimize inefficiencies due to taxes, consumers should be forced to consume more (less) of a good if the demand for that good has been discouraged (encouraged) by the tax system. By enhancing the efficiency of the system this policy tool increases the attainable level of redistribution from rich to poor by means of a higher marginal tax rate, t, and lump-sum transfer G.

With respect to the consequences of opening the borders, the possibility of costly mobility of students across the two countries has been shown to result in a lower level of public education provided independently by the two governments. This follows immediately from the fact that incoming students do not contribute to the financing of the school they attend although they do raise the tax revenue in their countries of origin. Foreign students impose a cost in the host country and a benefit to their home country when they move attracted by higher levels of expenditure in education.

Under these considerations, because each government is assumed to maximize its own welfare while taking the policy choice of the other as given, a symmetrical Nash equilibrium results in a lower provision level as compared to the autarchic case, in which no threat of inflow of students is present.

These conclusions call once more for coordination of fiscal policies in general and, in particular, of educative policies in a context of economic integration. In absence of agreement, all members are bound to implement sub-optimal policies that provide them with lower welfare levels than they would accomplish if the frontiers were closed. By cooperating, the countries should be able to set their public education provision at the optimal level. As everyone can be made better off while harming no-one, cooperation-operation yields a welfare improvement, and so it is unambiguously recommendable from an economic (efficiency) point of view.

Appendix

The purpose of this Appendix is to determine analytically the sign of

$$\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G}.$$

From $y_i = w_i(g + z_i)L_i$, we obtain:

$$\begin{aligned} \frac{\partial y_i}{\partial g} &= w_e^i L_i + \frac{\partial z_i}{\partial g} w_e^i L_i + w_i \frac{\partial L_i}{\partial g} \\ \frac{\partial y_i}{\partial G} &= \frac{\partial z_i}{\partial G} w_e^i L_i + w_i \frac{\partial L_i}{\partial G} \end{aligned}$$

so that

$$\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G} = w_e^i L_i + \left(\frac{\partial z_i}{\partial g} - \frac{\partial z_i}{\partial G} \right) w_e^i L_i + \left(\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G} \right) w_i \tag{A.1}$$

Differentiation of type-i individuals' first order conditions (2.2) and (2.3) yields the following comparative results. We first have, by Cramer's Rule:

$$\frac{\partial z_i}{\partial g} = \frac{\frac{\partial^2 u}{\partial z \partial L}\frac{\partial^2 u}{\partial L \partial g} - \frac{\partial^2 u}{\partial L^2}\frac{\partial^2 u}{\partial z \partial g}}{\frac{\partial^2 u}{\partial z^2}\frac{\partial^2 u}{\partial L^2} - \left(\frac{\partial^2 u}{\partial z \partial L}\right)^2},$$

$$\frac{\partial z_i}{\partial G} = \frac{\frac{\partial^2 u}{\partial z \partial L}\frac{\partial^2 u}{\partial L \partial G} - \frac{\partial^2 u}{\partial L^2}\frac{\partial^2 u}{\partial z \partial G}}{\frac{\partial^2 u}{\partial z^2}\frac{\partial^2 u}{\partial L^2} - \left(\frac{\partial^2 u}{\partial z \partial L}\right)^2},$$

and, hence

$$\frac{\partial z_i}{\partial g} - \frac{\partial z_i}{\partial G} = \frac{\frac{\partial^2 u}{\partial L^2}\left[\frac{\partial^2 u}{\partial z \partial G} - \frac{\partial^2 u}{\partial z \partial g}\right] + \frac{\partial^2 u}{\partial z \partial L}\left[\frac{\partial^2 u}{\partial L \partial g} - \frac{\partial^2 u}{\partial L \partial G}\right]}{\frac{\partial^2 u}{\partial z^2}\frac{\partial^2 u}{\partial L^2} - \left(\frac{\partial^2 u}{\partial z \partial L}\right)^2} \tag{A.2}$$

where,

$$\frac{\partial^2 u}{\partial z \partial G} - \frac{\partial^2 u}{\partial z \partial g} = ((1-t)w_e^i L - 1)u_{xx} - ((1-t)w_e^i L - 1)u_{xx}(1-t)w_e^i - u_x(1-t)w_{ee}^i L$$

Recall that, from (2.3), $(1-t)w_e^i L = 1$ when $z_i \geq 0$ is not binding. Thus,

$$\frac{\partial^2 u}{\partial z \partial G} - \frac{\partial^2 u}{\partial z \partial g} = -u_x(1-t)w_{ee}^i L = -\frac{\partial^2 u}{\partial z^2}$$

and

$$\frac{\partial^2 u}{\partial L \partial g} - \frac{\partial^2 u}{\partial L \partial G} = u_x(1-t)w_e = \frac{\partial^2 u}{\partial z \partial L},$$

so that we can conclude, from (A.2), that when the constraint $z_i \geq 0$ is not binding:

$$\frac{\partial z_i}{\partial g} - \frac{\partial z_i}{\partial G} = -1 \tag{A.3}$$

Also, from the comparative results we have:

$$\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G} = \frac{\frac{\partial^2 u}{\partial z^2}\left[\frac{\partial^2 u}{\partial L \partial G} - \frac{\partial^2 u}{\partial L \partial g}\right] + \frac{\partial^2 u}{\partial z \partial L}\left[\frac{\partial^2 u}{\partial z \partial g} - \frac{\partial^2 u}{\partial z \partial G}\right]}{\frac{\partial^2 u}{\partial z^2}\frac{\partial^2 u}{\partial L^2} - \left(\frac{\partial^2 u}{\partial z \partial L}\right)^2} \tag{A.4}$$

Differentiation of (2.2), yields:

$$\frac{\partial^2 u}{\partial L \partial G} - \frac{\partial^2 u}{\partial L \partial g} = -(1-t)w_e^i u_x = -\frac{\partial^2 u}{\partial z \partial L}$$

and

$$\frac{\partial^2 u}{\partial z \partial g} - \frac{\partial^2 u}{\partial z \partial G} = (1-t)w_{ee}^i L u_x = \frac{\partial^2 u}{\partial z^2}$$

when the constraint $z_i \geq 0$ is not binding. Implying, from (A.4):

$$\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G} = 0. \tag{A.5}$$

By substituting (A.3) and (A.5) back in (A.1) we obtain that:

$$\frac{\partial y_i}{\partial g} = \frac{\partial y_i}{\partial G} \text{ when } z_i \geq 0 \text{ is not binding.}$$

On the contrary, once the non-negativity constraint on $z_i \geq 0$ becomes binding ($g = g_i$), z_i remains constant at zero. Then:

$$\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G} = w_e^i L_i + w_i(\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G}) \tag{A.6}$$

and, from (A.4):

$$\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G} = \frac{\partial^2 u}{\partial L \partial G} - \frac{\partial^2 u}{\partial L \partial g} = \frac{(1-t)w_e^i u_x}{-\frac{\delta^2 u}{\delta L^2}} > 0. \tag{A.7}$$

Hence, (A.7) back in (A.6) shows that:

$$\frac{\partial y_i}{\partial g} - \frac{\partial y_i}{\partial G} > 0 \text{ at } g = g_i.$$

However, as public provision g is increased further, it is no longer true, as it is at $g = g_i$, that $(1-t)w_e^i L = 1$. Therefore,

$$\frac{\partial L_i}{\partial g} - \frac{\partial L_i}{\partial G} < 0 \text{ at } g > g_i.$$

References:

Boadway, R. and Marchand, M.(1995): The use of Public Expenditures for Redistributive Purposes. Oxford Economic Papers 47, 45-59.

Boadway, R., Marchand, M. and Sato, M.(1997): Subsidies versus Public Provision of Private Goods as Instruments for Redistribution. CORE DP # 9771.

Gahvari, F.(1995): In-kind versus Cash Transfers in the Presence of Distortionary Taxes. Economic Inquiry 33 (1) 45-53.

Guesnerie, R. and Roberts K. (1984): Effective Policy Tools and Quantity Controls. Econometrica, 52, 59-86.

Mansoorian, A. and Myers, G. M. (1993): Attachment to home and efficient purchases of population in a fiscal externality economy. Journal of Public Economics 52, 117-132.

Munro, A. (1991): The Optimal Public Provision of Private Goods. Journal of Public Economics 44 239-261.

Wildasin, D. E. (1988): Nash Equilibria in models of Fiscal Competition. Journal of Public Economics 35, 229-240.